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A Detailed Study on Analysis of Cylinder Head

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***Abstract* - I.C motor cylinder is a standout amongst the most vital and complex part in the motor. It is additionally some of the time alluded as the heart of motor. It is generally utilized primarily as a part of car and mechanical fields subsequently, a nitty gritty review on its static conduct is essential. This paper underlines on the static investigation of the cylinder leader of a 4-stroke I.C motor. In the present work cylinder head is outlined utilizing CATIAV5R20 and this model is broke down in ANSYS 14.5 and a review on its static conduct is performed. Aluminum composite has been chosen as cylinder material for basic examination. The hypothetical anxiety values got is contrasted and the anxiety values acquired after the investigation in ANSYS 14.5.**

***Index Terms*— Cylinder Head, I.C Engine, CATIA V5R20, ANSYS 14.5, Static Analysis**.

I. INTRODUCTION

Piston is one of the most important components of engine. It is a part in motion which is present in cylinder. In the engine the expansion of gas occurs in cylinder up to crankshaft through connecting rod. The piston lasts this gas pressure and inertial forces at work and this may lead to crack formation and piston wear. The study reports show that stress concentration is highest at upper portion and this is one of the main reasons for crack formation and wear. This paper describes stress distribution on piston head of an IC engine by using finite element method. It is achieved by CAD and CAE software. Our main purpose is to study the static behavior of piston head and analyze the stress distribution. By using CATIAV5R20 model of the piston head is developed. Stress analysis is carried out by using ANSYS 14.5. The results obtained from ANSYS 14.5 are compared with the calculated theoretical stress values. Christo Ananth et al. [5] proposed a system about Efficient Sensor Network for Vehicle Security. Today vehicle theft rate is very high, greater challenges are coming from thieves thus tracking/ alarming systems are being deployed with an increasingly popularity .As per as security is concerned today most of the vehicles are running on the LPG so it is necessary to monitor any leakage or level of LPG in order to provide safety to passenger. Also in this fast running world everybody is in hurry so it is required to provide fully automated maintenance system to make the journey of the passenger safe, comfortable and economical. To make the system more intelligent and advanced it is required to introduce some important developments that can help to promote not only the luxurious but also safety drive to the owner. The system "Efficient Sensor Network for Vehicle Security", introduces a new trend in automobile industry.

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II. MATERIAL PROPERTIES

Aluminum alloy is selected for the design and analysis of the piston head. Properties of the aluminum alloy are mentioned below.

TABLE I: PARAMETERS AND VALUES

Parameter	Value
Density	2770 (Kg/m3)
Poisson Ratio	0.33
Young Modulus	7.1x1010 (Pa)
Thickness of the piston head by considering the heat dissipation	t1 = D2q / [1600×K× (Tc-Te)] mm

III.CALCULATIONS

Bore diameter = 100 mm (D),
Stroke length = 120 mm (L),
Gas pressure = 5
MP_a, BMEP = 0.5 MP_a,
Fuel consumed =0.15 (Kg) / Brake Power (W),
Speed = 2200 rpm (N)

Step 1:

Brake power (BP) .in KW
BP = PLAN/ (1000×60) KW

Where, P = BEMP = 0.5 MP_a
L = Stroke length m
A = Cross Section area m^2
N = Speed rpm^2
BP = 0.5×120×100 ×2200×π/ (1000×4×60)
= 17.275 **KW**

Step 2:

Where, t_1 = thickness of piston head mm
q = Heat flow J/*s*-m^2
k = Heat conductivity W- mm/ (m^2-^{0}c)
T_c-T_e = difference between the Temperature at centre and edges =222 K
q = K_1×C×W×BP/(A) J/s-m^2

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Where, K_1 = Constant which represents the amount of heat soaked by piston.
C = Calorific value of the fuel = 42000 KJ/Kg
W = fuel consumed = 0.15 Kg-hr/KW
$A = \pi d^2/ (4) = \pi \times (0.1)^2/ (4) = 7.85\times10^{-3}$ m^2
$q = 0.05\times (42000\times1000) \times (0.15/3600)\times17.278/ (7.854\times10^{-3}) = 192491$ J/s-m^2
$t_1 = 1002\times192491 / (1600\times460\times222) = 11.78$ mm

Step 3: The thickness of the piston head using Grashof"s formula

$t_1 = 0.43\ D\sqrt{}\ (P/\sigma t)$ mm
P = Gas pressure in MP_a
σt = Allowable tensile stress MP_a
= 280/2.25
= 124.4 MP_a
D = 100 mm
$= 0.43\times100\ \sqrt{}\ (5/124)$
= 8.7 mm = 9 mm
Adopt the greater value of the t_1 i.e). t_1 = 11.78 mm

Step 4: Piston ring properties

The radial thickness of the ring t_r

$t_r = D\times\sqrt{}(3Pr/\ \sigma t)$ mm
Where, Pr is pressure exerted by fuel on cylinder wall in N/mm^2. Its value varies from 0.025 to 0.042N/mm^2
$= 100\times\sqrt{}\ (3\times0.042/124)$
= 3.187 mm

The distance from top to first groove t_g

$t_g = 1t_1$ to $1.2t_1$
$= 1.2\times11.78$
= 14 mm Number of rings i
$i = 100/ (10\times h)$
$= 100/ (10\times2.22) = 4$ rings

The maximum thickness of piston barrel t_3

$t_3 = 0.03D + b + 4.5$ mm
Where, b is the depth of the ring grooves in mm
$b = t_r + 0.4$ mm
$= 3.187+0.4$

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= 3.587 mm
t_3 = 0.03×100 + 3.587 + 4.5
= 11.08 mm
Thickness of the wall towards the open end of the piston t_4

t_4 = 0.25 t3 to 0.35t3
= 0.25×11.08
= 3.32 mm
Diameter of the piston pin d = $\pi \times D2 \times P_{max} / (4 \times l1 \times P_b)$

Where, l1 = 1.5d
P_b is bearing pressure in MP_a which is 15.7 for aluminum alloys.
= $\pi \times 1002 \times 5 / [4 \times (1.5d) \times 15.7]$
d = 40.83 mm

Step 5: Theoretical Stress Calculation

$\sigma b = M_b / W_b$ MP_a
Where M_b is the bending moment and
W_b is the moment of resistance to the bending
$M_b = 1/3 \times P_{max} \times r$ 3 MNm
P_{max} = Maximum gas pressure in MP_a.
This value varies between 2 to 5 MP_a in case of aluminum alloys. [3]
r_i = crown inner radius m
$W_b = 1/3 \times G \times r_i^2$ m_3
G = Thickness of piston crown m
$r_i = [D/2-(s+t_r+d_t)]$ m
d_t = Radial clearance between piston rings and channel m
s = Thickness of the sealing part m
= [0.1/2-(0.005+0.0008+0.0031)] = 0.0413 m
M_b = 1/3×5×0.04133
= 1.174×10-4 MNm
G = (0.08 to 0.1) D m
= 0.091×100
= 9.1 mm
W_b = 1/3×0.0413×0.00912
= 1.14×10^{-6} m_3
$\sigma b = 1.17 \times 10^{-4} / 1.14 \times 10^{-6}$
= 103 MP_a

The theoretical stress value obtained is less than the allowable stress (103<124 MP_a). Hence the design is safe. Christo Ananth et al. [4] discussed about Improved Particle Swarm Optimization. The fuzzy filter based on particle swarm optimization is used to remove the high density image impulse noise, which occur during the transmission, data acquisition and

processing. The proposed system has a fuzzy filter which has the parallel fuzzy inference mechanism, fuzzy mean process, and a fuzzy composition process. In particular, by using no-reference Q metric, the particle swarm optimization learning is sufficient to optimize the parameter necessitated by the particle swarm optimization based fuzzy filter, therefore the proposed fuzzy filter can cope with particle situation where the assumption of existence of "ground-truth" reference does not hold. The merging of the particle swarm optimization with the fuzzy filter helps to build an auto tuning mechanism for the fuzzy filter without any prior knowledge regarding the noise and the true image. Thus the reference measures are not need for removing the noise and in restoring the image. The final output image (Restored image) confirm that the fuzzy filter based on particle swarm optimization attain the excellent quality of restored images in term of peak signal-to-noise ratio, mean absolute error and mean square error even when the noise rate is above 0.5 and without having any reference measures. Christo Ananth et al. [6] discussed about Intelligent Sensor Network for Vehicle Maintenance System. Modern automobiles are no longer mere mechanical devices; they are pervasively monitored through various sensor networks & using integrated circuits and microprocessor based design and control techniques while this transformation has driven major advancements in efficiency and safety. In the existing system the stress was given on the safety of the vehicle, modification in the physical structure of the vehicle but the proposed system introduces essential concept in the field of automobile industry. It is an interfacing of the advanced technologies like Embedded

Systems and the Automobile world. This "Intelligent Sensor Network for Vehicle Maintenance System" is best suitable for vehicle security as well as for vehicle's maintenance. Further it also supports advanced feature of GSM module interfacing. Through this concept in case of any emergency or accident the system will automatically sense and records the different parameters like LPG gas level, Engine Temperature, present speed and etc. so that at the time of investigation this parameters may play important role to find out the possible reasons of the accident. Further, in case of accident & in case of stealing of vehicle GSM module will send SMS to the Police, insurance company as well as to the family members. Christo Ananth et al. [7] discussed about an eye blinking sensor. Nowadays heart attack patients are increasing day by day. "Though it is tough to save the heart attack patients, we can increase the statistics of saving the life of patients & the life of others whom they are responsible for. The main design of this project is to track the heart attack of patients who are suffering from any attacks during driving and send them a medical need & thereby to stop the vehicle to ensure that the persons along them are safe from accident. Here, an eye blinking sensor is used to sense the blinking of the eye. SpO2 sensor checks the pulse rate of the patient. Both are connected to micro controller.

If eye blinking gets stopped then the signal is sent to the controller to make an alarm through the buffer. If spO2 sensor senses a variation in pulse or low oxygen content in blood, it may results in heart failure and therefore the controller stops the motor of the vehicle. Then Tarang F4 transmitter is used to send the vehicle number & the mobile number of the patient to a nearest medical station within 25 km for medical aid. The pulse rate monitored via LCD .The Tarang F4 receiver receives the signal and passes through controller and the number gets

displayed in the LCD screen and an alarm is produced through a buzzer as soon the signal is received. Christo Ananth et al. [8] discussed about a system, GSM based AMR has low infrastructure cost and it reduces man power. The system is fully automatic, hence the probability of error is reduced. The data is highly secured and it not only solve the problem of traditional meter reading system but also provides additional features such as power disconnection, reconnection and the concept of power management. The database stores the current month and also all the previous month data for the future use. Hence the system saves a lot amount of time and energy. Due to the power fluctuations, there might be a damage in the home appliances. Hence to avoid such damages and to protect the appliances, the voltage controlling methodcan be implemented. Christo Ananth et al. [9] discussed about a project, in this project an automatic meter reading system is designed using GSM Technology. The embedded micro controller is interfaced with the GSM Module. This setup is fitted in home. The energy meter is attached to the micro controller. This controller reads the data from the meter output and transfers that data to GSM Module through the serial port. The embedded micro controller has the knowledge of sending message to the system through the GSM module. Another system is placed in EB office, which is the authority office. When they send "unit request" to the microcontroller which is placed in home. Then the unit value is sent to the EB office PC through GSM module. According to the readings, the authority officer will send the information about the bill to the customer. If the customer doesn't pay bill on-time, the power supply to the corresponding home power unit is cut, by sending the command through to the microcontroller. Once the payment of bill is done the power supply is given to the customer.

Power management concept is introduced, in which during the restriction mode only limited amount of power supply can be used by the customer.
In [10], the development in technology has given us all sophistications but equal amounts of threats too. This has brought us an urge to bring a complete security system that monitors an object continuously. Consider a situation where a cargo vehicle carrying valuable material is moving in an area using GPS (an outdoor sensor) we can monitor it but the actual problem arises when its movement involves both indoor (within the industry) and outdoor because GPS has its limitations in indoor environment. Hence it is essential to have an additional sensor that would enable us a continuous monitoring /tracking without cutoff of the signal. In this paper we bring out a solution by combining Ultra wide band (UWB) with GPS sensory information which eliminates the limitations of conventional tracking methods in mixed scenario(indoor and outdoor).

The same method finds application in mobile robots, monitoring a person on grounds of security, etc. Christo Ananth et al. [11] discussed about Nano robots Control Activation for Stenosed Coronary Occlusion, this paper presents the study of Nano robots control activation for stenosed coronary occlusion, with the practical use of chemical and thermal gradients for biomedical problems. The recent developments on nanotechnology new materials allied with electronics device miniaturization may enable Nano robots for the next few years. New possibilities for medicine are expected with the development of Nano robots. It may help to advance the treatment of a wide number of diseases: cardiovascular problems, neurosurgery,

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cancer, diabetes and new cell therapies.

The implementation of new methodologies to help on manufacturing analyses and system design for the development of Nano scale molecular machine is one of the most important fields for research. The use of 3D physically based simulation in conjunction with clinical data may provide ways to design practical approaches for control and transducers development. Christo Ananth et al.[12] discussed about E-plane and H-plane patterns which forms the basis of Microwave Engineering principles.

IV. STRUCTURAL ANALYSIS

A. Restraining the Model at Piston Pin Holes

Cylinder stick gaps are considered as settled support. Thus frictionless support is connected and it is limited at its gaps.

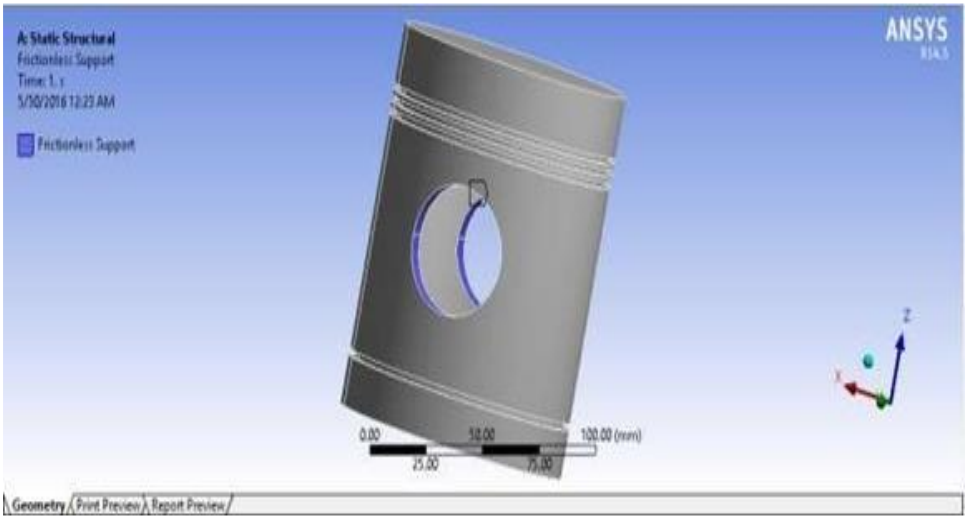

Fig 1. Restraining the model at piston pin holes

B. Applying Pressure on Top Surface

For static basic investigation the weight of size 5 MP_a is connected on the top surface of the cylinder head. The gas burning weight for aluminum compound is 5 MP_a.

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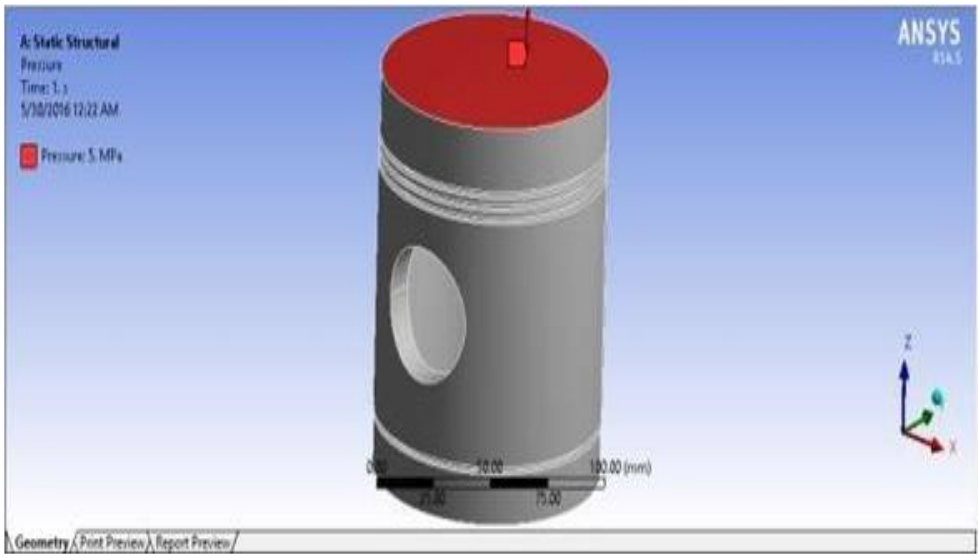

Fig 2. Applying the pressure on top surface of piston head

V. RESULTS

The model is fathomed in the wake of applying the weight and results are acquired for Von-Mises push and basic misshaping which are demonstrated as follows. The estimation of auxiliary distortion got is 0.7314 mm and stress esteem acquired is 103.32 MP_a.

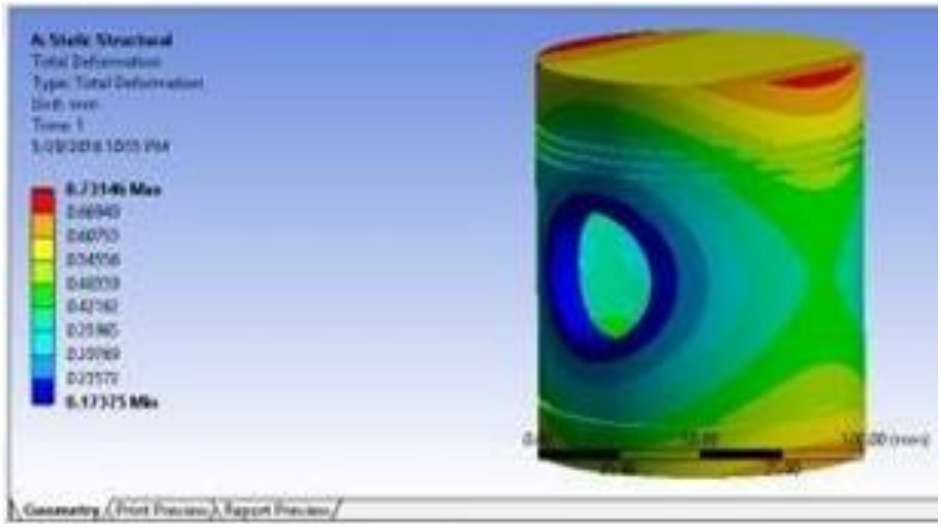

Fig 3. Results obtained for Structural deformation of piston head

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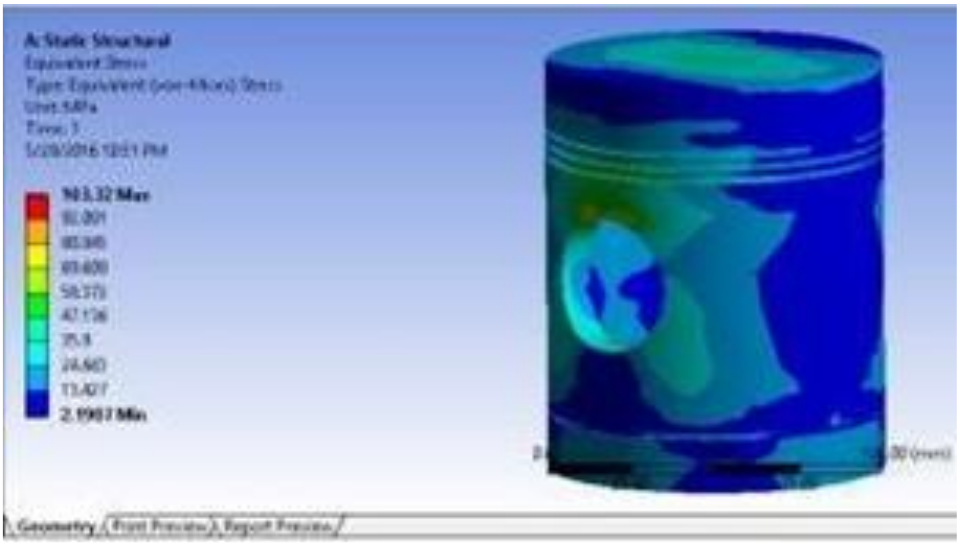

Fig 4. Results obtained for stress in Cylinder head

VI. CONCLUSION

As the Engine barrel is a champion among the most imperative and complex part in the engine. It is also as a rule implied as the heart of engine. It is for the most part used principally as a piece of auto and mechanical fields along these lines, a bare essential audit on its static lead is fundamental. This paper underlines on the static examination of the chamber pioneer of a 4-stroke I.C engine. In the present work chamber head is laid out using CATIAV5R20 and this model is penniless down in ANSYS 14.5 and a survey on its static lead is performed. Aluminum composite has been picked as barrel material for fundamental examination. The theoretical tension qualities got is differentiated and the uneasiness values procured after the examination.

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